

STUDIES OF TWO RARE TIGER BEETLES (*CICINDELA PURITANA* AND *C. D. DORSALIS*) IN MARYLAND, 2009

Distribution and abundance of *Cicindela d. dorsalis* and *C. puritana* in
Calvert County and the Eastern Shore of Maryland

FINAL REPORT

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Photo by Chris Wirth

**From: C. Barry Knisley
Dept of Biology, Randolph-Macon College, Ashland, VA 23005**

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Forest, Wildlife, and Heritage Service
Maryland Department of Natural Resources
580 Taylor Ave., E-1
Annapolis, MD 21401**

ABSTRACT

*This report includes the results of continuing monitoring of *C. puritana* and *C. d. dorsalis* at all sites in Calvert County, the Sassafras River mouth and Janes and Cedar Islands, Maryland, in 2009. **Puritana.** The total number of adult *C. puritana* at all **Calvert** sites in 2009 was 2118, indicating a significant decrease from the two recent years' high counts of 5721 in 2008 and 3946 in 2006, but more similar to the 2625 in 2007. The decline may be explained in part by the pattern of alternate year abundance in which odd year cohorts have been significantly lower than even years. Numbers in the years before the increase (2002, 2003, 2004, 2005) were less than 2100 adults. The 2009 results do not necessarily counter a general pattern of significant increase since 1999 since the lower count in 2009 could be expected due to the lower count in 2007 cohort. The 2009 decline (from 2008) occurred at most sites but was greatest at several large population sites: Calvert Cliffs State Park (1609 in 2008, 666 in 2009), Little Cove Point (1116 in 2008, 330 in 2009), Cliffs of Calvert (829 in 2008, 219 in 2009), Warriors Rest (958 in 2008, 466 in 2009), and Western Shores/Calvert Beach (841 in 2008, 143 in 2007).*

*The results of surveys at all **Sassafras River** sites produced a count of 837 in 2009 compared to 1764 in 2008 and 1566 in 2007. This count indicates a significant decline after a progressive and significant increase from 2004 to 2008 (398 in 2004, 408 in 2005, 1221 in 2006). Prior to these years, the total counts declined significantly from 1996 (count of 1821) to 2002 (400). Numbers in 2009 showed a consistent and similar proportional decline at all sites (except for a slight increase at East Lloyd) from 2008, with most of the decrease attributed to the decline at Grove Point which has the largest population in the Sassafras. This pattern of 5 years of increase followed by a decrease in 2009 is similar to that in the Calvert metapopulation. Some, perhaps much of the low counts in 2009 can be attributed to the unusually high tides during the time of most counts which reduced beach width and thus adult activity area, and at Grove Point caused cliff breakdown in several sections as the survey was being made.*

*These year to year fluctuations of *C. puritana* at both Calvert and Sassafras sites over the years have been the norm, and reflect variations in recruitment, possibly tied to changes in habitat conditions or climatic factors. However, we have not been able to effectively determine what these specific factors are and the nature of their impacts. We hypothesized that Hurricane Isabel in 2003 may have had a delayed positive effect by reducing vegetation and creating more favorable habitat, possibly for both *C. puritana* and *C. dorsalis*. This could have resulted in pattern of gradual increase that we have seen in these recent years. Hurricanes and other erosional events can clear out cliff base or cliff face vegetation, making these areas more favorable for adult oviposition and recruitment. In any event it is significant that overall patterns of abundance have been similar in both areas suggesting it is climatic/storm/erosional driven. Additional aspects of the beetle biology (density dependent population dynamics, competition, parasitism, etc.) may also be involved in driving changing levels of abundance, but these have not been identified.*

***Dorsalis.** The total count for adult *C. dorsalis* at all **Calvert** sites in 2009 was 78 (6 at Flag Ponds, 72 at Western Shores). This number represents a progressive, stepped and significant decline of abundance for this metapopulation since the early to mid-1990s when numbers ranged from over 3000 to over 10,000. Numbers declined but were as high as 3014 in 2003, then declined to counts in the 700s from 2004 to 2007 and 190 in 2008. No obvious observed habitat changes were observed at these two sites in the past 3-4 years to explain the decline. The survival of this metapopulation with only two remaining small populations continues to be in jeopardy of survival, unless there is a significant increase in 2010. In contrast the **Eastern Shore** counts in Maryland have been high in most years and in 2009 were 1330 at Janes and 974 at Cedar Island in 2009. Numbers peaked at both sites in 2002 with 6094 at Janes and 2464 at Cedar. Although these sites have fluctuated significantly in abundance, including a second lowest count at Cedar in 2009, numbers have been high most years, the populations viable and the sites undisturbed by human activity.*

INTRODUCTION AND METHODS

Annual surveys for adults of *C. puritana* and *C. d. dorsalis* have been conducted at all Maryland sites since 1988, and are among the longest period of monitoring population size for any insect species. The objective in 2009 as in all previous years was to determine the distribution and abundance of these two species at all current sites in Maryland so counts can be compared with previous years and trends of abundance identified. In all years we have used the same methods and conducted surveys during the season of peak adult abundance and on days when conditions are optimum. This has provided an understanding of population dynamics at various sites and given insight on implementing protection and management strategies. Earlier studies showed that peak abundance is typically from the last week in June through mid-July. Surveys in 2009 were conducted between June 25 and July 17, on days that were sunny with temperatures in the mid 80's to low 90's. Most sites were surveyed at low to mid-tide and when the sun was on the beach and cliff base. Under these conditions a high level of adult activity is expected. If conditions were different on a particular survey day, it is noted below. The survey method we used, as in previous years, involved one person walking slowly along the shoreline near the water edge and counting all adults that were seen on the ground surface 5-10 m ahead. In areas where there was a narrow beach or cliffs near the water, the base of the cliffs was also examined and beetles there included in the count. In sections of wider beach the surveyor moved more slowly so the back portions of the beach could be surveyed. Since 2004 the counts have been made and reported within the same sections of shoreline and these verified using a GPS unit to reference these specific locations. These locations are shown as numbered waypoints on topo maps included with this report and the adult numbers within these sections shown in Tables 4-6 below. Shoreline characteristics were also recorded for each of these sections and included in the report tables.

RESULTS AND DISCUSSION

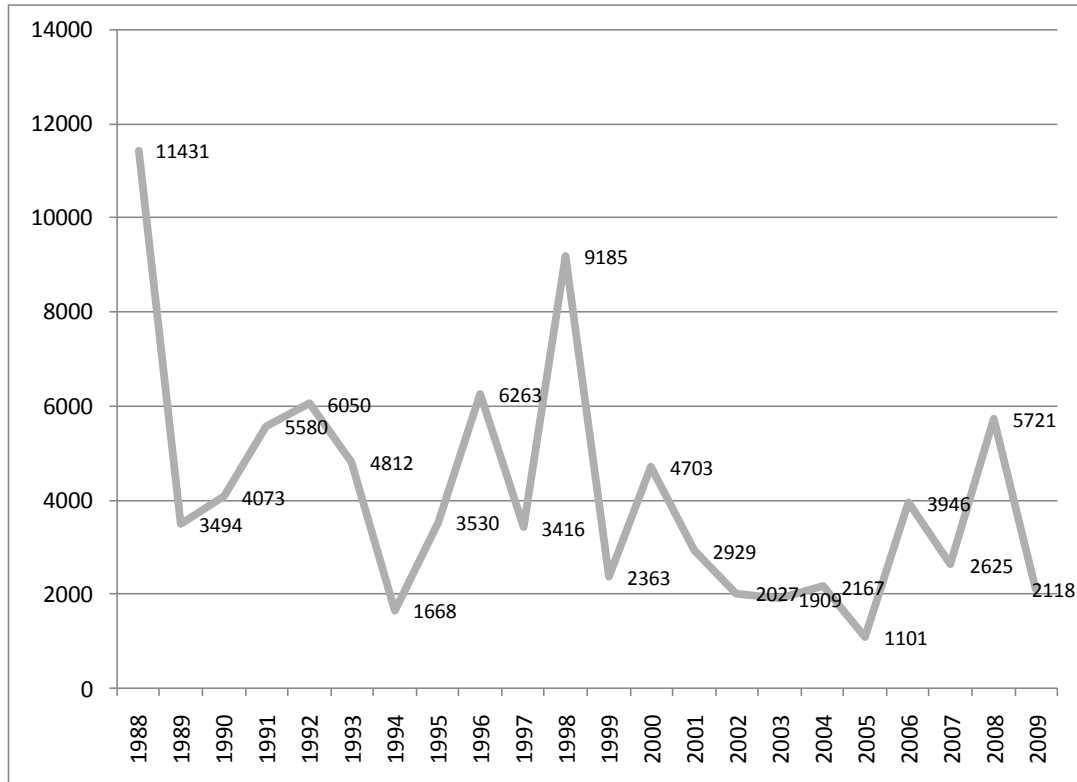
Summary of Calvert *C. puritana* Trends. The total number of adult *C. puritana* at all Calvert sites in 2009 was 2118 (Fig. 1, Table 1). This count represents a significant decrease from two recent years of high counts of 5721 in 2008 and 3946 in 2006, but is very similar to the 2625 in 2007. The decline may be explained, at least in part, by the pattern of alternate year abundance seen with this species. Numbers in all other recent years (2002, 2003, 2004, 2005) were less than 2100 adults. The 2009 results do not refute what seems to be a general pattern of significant increase since 1999 since the lower count in 2009 might be expected because of lower numbers in 2007. The 2009 decline (from 2008) is primarily a result of very large decreases at several large population sites: Calvert Cliffs State Park (1609 in 2008, 666 in 2009), Little Cove Point (1116 in 2008, 330 in 2009), Cliffs of Calvert (829 in 2008, 219 in 2009), Warriors Rest (958 in 2008, 466 in 2009), and Western Shores/Calvert Beach (841 in 2008, 143 in 2007). These year to year fluctuations have been common during the many years of these surveys, and reflect variations in recruitment, possibly tied to changes in habitat conditions caused by climatic/storm/erosional factors.

However, we have not been able to effectively determine what these specific factors are and the nature of their impacts. We hypothesized that Hurricane Isabel in 2003 may have had a positive effect on population size by reducing vegetation and creating more favorable habitat which in turn could have resulted in the pattern of gradual increase that we have seen in these recent years. Hurricanes and other erosional events can clear out cliff base or cliff face vegetation, making these areas more favorable for adult oviposition and recruitment. The delayed response in population build-up is expected because of the two-year life cycle of the beetle. There may also be other weather effects or aspects of the beetle biology (density dependent population dynamics, competition, parasitism) that are driving changing levels of abundance, but these also have not been identified.

Table 1. Total index counts for *C. puritana* at all Calvert County sites, 1986 to 2009.

Year	Rand	CRsv	Bays	Wrest	ScCI	WS+CB	CCNP	CCSP	LCov	CofC	Total
1986	200	20	72		1000				250		1542
1988	93	73	22		3571	4891		2194	328	259	11431
1989	119	4	6		1491	1052		702	85	35	3494
1990	133		64		1342	1747		643	102	42	4073
1991	57	17	38		2057	1653		835	738	155	5550
1992	65	10	75		2029	767		2565	232	307	6050
1993	68	2	68		2007	731		1177	538	221	4812
1994	24		19		681	101		756	87		1668
1995	82	12	119		1146	1150		541	340	140	3530
1996	45	0	66		1904	1489		919	927	913	6263
1997	75	2	51		1091	851	119	507	525	195	3416
1998	83	1	44		3792	2597	616	984	566	502	9185
1999	29	0	41		408	1169	49		373	294	2363
2000	11	0	22		2317	1161	367		462	363	4703
2001	234	2	109		1375	502			352	355	2929
2002	52	0	28		691	621	80		397	158	2027
2003	31	0	149		256	577	226		586	84	1909
2004	27	0	0		447	1279	121		251	42	2167
2005	31	0	2	155	111	232		242	298	30	1101
2006	25	0	6	1366	218	1123	105	338	612	111	3904
2007	21	0	14	631	206	273	276	292	740	172	2625
2008	23	0	5	958	218	841	122	1609	1116	829	5721
2009	7	0	1	466	45	143	241	666	330	219	2118
Total	1535	143	1021	3576	28403	24950	2322	14970	10235	5426	
1986 surveys were incomplete											

Fig. 1. Total index counts for *C. puritana* adults in Calvert County, 1988 to 2009.



Accounts for Individual Calvert Sites. Table 5 (Appendix) gives the detailed results for all Calvert sites in 2009 along with years 2004-2008. These are years when we used standard waypoints at each site. Included are the adult numbers for *C. puritana* within each waypoint section, shoreline characteristics for each section of shoreline, and the coordinates for each waypoint. The locations of these waypoints are shown on the topographic maps included in the appendix of this report.

Randall Cliffs. This is the northernmost *C. puritana* site in Calvert County and has had consistently low numbers, especially low in all but one of the past 10 years. Numbers of adults have typically been less than 100 since 1990, except for a count of 234 in 2001. The count of 7 adults in 2009 is the lowest ever count and compares with 23 in 2008. A possible explanation for this unusually low count in 2009 may have been due to especially high water levels, even at low tide when the counts were made. This site has not supported a large population in most years, especially recently, probably because of the limited suitable cliff substrate for larvae (seemingly too dry and with too little sand content). The shoreline is also very narrow with little adult foraging area. Typically, all adults have been found scattered in the few sections of wider beach. Also, there seems to be evidence of progressive and significant erosion throughout this site, especially the southern portion in the past 10 years that has eliminated some former habitat.

Camp Roosevelt. As in each survey since 2002, no adults were found at this site again in 2009, further confirming the loss of this population. Even in earlier years counts at this site have been low, although 73 adults were found here in 1988. Records from collectors in the 1950's and 1960's suggest this site may have once supported a larger population. This site includes a long length of shoreline and cliffs, but much of the beach is narrow and/or the cliffs dry with little sand content, and little apparent suitable larval habitat for oviposition.

Bayside Forest. Only 1 adult was found at this site in 2009 compared to 5 in 2008, 14 in 2007, 6 in 2006, 2 in 2005 and none in 2004. There were only 6 adults in 1989, but most other earlier years had 40 or more adults, with a peak number of 149 in 2003. Most of the beetles have been in the area of waypoint 31. Observations during the 2004 survey indicated this site experienced very severe erosion due to Hurricane Isabel. Most of the shoreline and especially the southern portion where beetles were always most common lost several meters or more of cliff face with extensive cliff breakdown and trees littering the beach and cliff base. There were also tracks and compaction from heavy equipment on the beach, apparently being used to clear the beach of downed trees. In 2005 there was no evidence of the downed trees and rubble or of heavy equipment on the beach. By 2007 to present it appeared that the beach and cliffs have generally recovered from these earlier disturbances, but the beetle population has not increased and remains in serious danger of going extinct.

Warrior Rest and Scientists Cliffs. This very long section of shoreline is now separated into two sites because of differences in ownership and management. In previous years the beetle counts were combined and listed as Scientists Cliffs. The Warrior Rest count in 2009 was 466 compared to 958 last year, 633 in 2007, and 1388 in 2006. This decline may indicate the pattern of alternate year abundance rather than any significant habitat changes which were not apparent in 2009. The distribution of adults at this site in 2009 was similar to other recent years with highest densities at waypoints 36-39 and lower densities further north. Few or no adults were present at the northernmost part of the site. This site is of interest since most of the shoreline has a narrow to very narrow beach, yet densities are extremely high, probably because cliff habitat is ideal for recruitment and larval survival.

The Scientists Cliffs population declined to 45 adults in 2009 compared to 218 in 2008, 206 in 2007, 213 in 2006 and 111 in 2005. This was the lowest count in any recent years and not explained by the alternate year abundance pattern. As in past years most beetles were absent or at very low numbers in most of the long northern section of this site which has groins throughout. In this section the few adults were in localized remaining patches of open cliff habitat among the vegetated, low or no cliff shoreline. The other limited concentration of adults was at the far south end of the site (waypoints 56-59) where there are no groins and some suitable bare cliff habitat. Observations in recent years suggest that much of the suitable habitat along the middle and northern section of Scientists Cliffs (the long section adjacent to Warrior Rest) has deteriorated due to increasing vegetation, apparently caused by the very extensive groin field along this portion of the shoreline. Some new groins have been added, but most are several

decades old. However, the bulk of the population at these two sites has historically been the Warrior Rest section, and if this site continues to produce large numbers, the viability of this population and the whole Calvert metapopulation will be significantly improved. The Warriors Rest section has clearly experienced significant shoreline erosion in the past ten years and this may have contributed to lower counts in recent years compared to 10-20 years ago. Regardless, the cliff habitat in the Warrior Rest section continues to be the best habitat for larvae in Calvert.

Western Shores/Calvert Beach. These two sites are now combined because they are adjacent shoreline sections and have comparable private ownership. This is also logical because they are part of the same section of shoreline and the same populations of *C. puritana* and *C. dorsalis*. This is the only site in Maryland with large populations of both species. The total number of *C. puritana* in 2009 declined to 145 compared to 841 in 2008, 273 in 2007, 886 in 2006, and 232 in 2005. These recent counts as at several other sites can be quite convincingly explained by the pattern of alternate year abundance. Odd year cohorts have been lower in most of the past 10 years at this site and even year cohorts significantly higher. As in previous years, the *C. puritana* were restricted to the middle section of this combined site which is the southern end of the Western Shores and northern part of Calvert Beach where cliffs are very well developed and beaches wider than most other *C. puritana* sites. The 2009 distribution and abundance are very similar to in other recent years. Although, Hurricane Isabel improved the habitat at this site by washing out some of the back beach vegetation and pushed sand onto the beach, this site continues to experience rapid back beach and low cliff vegetation growth. This vegetation now includes larger trees and dense shrubs which probably block the movement of adults of *C. puritana* up and down the cliffs as they switch from foraging on the beach to oviposition on the cliff face. At present, however, the population is viable although with lower beetle numbers and lower habitat quality than in the early 1990's. This site may continue to deteriorate in quality because the vegetation is so well established with larger trees and shrubs may not be affected by storm activity.

Calvert Cliffs Nuclear Power Plant. This shoreline site has supported a moderate population of *C. puritana*, with highly variable counts over the years (high of 616 in 1998 and low of 49 in 1999). The 2009 count was 241 and higher than most recent years (122 in 2008, 276 in 2007, 109 in 2006, and 121 in 2004). In 2009 as in most other years adults have most abundant in the southern part of the site (waypoints 115-118) where there is wider beaches along with suitable cliffs. There is also moderate abundance of beetles in the middle of the shoreline but very few adults in the northern third of the shoreline. Nearly all of this site except the southern end has a very narrow and very rocky beach which is not suitable for adult foraging and contributes to the overall lack of suitable habitat in these areas.

Calvert Cliffs State Park. The counts at this site had a very dramatic increase in 2008 when 1609 adults were found. Numbers declined to 666 in 2009 but were still significantly higher than in other recent years (292 in 2007, 338 in 2006, and 242 in 2005). In all years, adults have been found along nearly the whole length of the three

cliff sections at the site and absent or very sparse in the two marsh beach sections which separate the cliffs. Increases in the past two years were seen in all of the waypoint sections (except 202), and especially in waypoint sections 201-203 and 207. As in several other sites, there was no obvious shoreline or cliff changes apparent at this site in the past few years. No counts were made at this site from 1999 through 2004, but from 1988 to 1998, counts were over 600-700 in most years, with a peak of 2194 in 1988. The site has experienced significant shoreline and cliff erosion resulting in closure of the cliff sections to the public about 8 years ago. It is possible that this high and persistent erosion contributed to the lower counts in recent years, but ultimately to new habitat and increased recruitment to produce high numbers in the past two years.

Little Cove Point. This long section of shoreline has extensive cliffs and mostly narrow to moderate width beaches. It has consistently (except for a very few years) supported a medium to large population of *C. puritana*. The count was 330 in 2009, a very significant decline from the count of 1116 in 2008 and 4 years of progressively increasing abundance. The 2008 count was the highest ever and compares with the previous high counts of 927 in 1996 and 738 in 1991. The reduced numbers in 2009 seems to be at least in part a result of significant cliff erosion which could have destroyed pupae or prepupae. Many small to large cliff breakdowns were seen along the shoreline during the surveys several in areas where numbers declined significantly in 2009 (see Table 5). Several other breakdowns also occurred in 2008. The distribution of adults at the site has been comparable to other recent years, with adults very widely distributed and consistently present along most of the site length, except for the north end and near the south end. The site continues to have good cliff habitat and suitable beaches, but seems to have deteriorated in several sections of new shoreline modifications (reef ball projects and revetment).

Cliffs of Calvert. This site borders the above site and supports the same *C. puritana* population. The adult count in 2009 was 219 compared to 829 in 2008 (the second highest count ever). The pattern of abundance at this site was comparable to that of Little Cove, both showing progressive increase and then a significant decline in 2009. Also like Little Cove, several new large breakdowns were observed here in shoreline sections that experienced major beetle declines (waypoints 184-185). As in previous years, most of the adults in 2009 were in the middle section of the site, waypoints 179 to 186. The limiting factor at this site may be the narrow beaches over most of the site's length since there appears to be fairly extensive tall cliffs with suitable substrate.

Summary of Calvert County *C. d. dorsalis* Trends. The total count for adult *C. dorsalis* at all sites in 2009 was 72. This number represents a progressive, stepped and significant decline of abundance for this metapopulation since the early to mid-1990s when numbers ranged from over 3000 to over 10,000. Numbers declined but were as high as 3003 in 2003, then declined to relatively consistent counts in the 700s from 2004 to 2007. There was another significant decline to 190 in 2008 and now 78 in 2009 (Table 2, Fig. 2). This survival of this metapopulation with two remaining populations continues to be in jeopardy of survival, unless there is a significant increase in 2010.

In the early 1990's populations of *C. dorsalis* were present at Cove Point, but that population declined gradually throughout the 1990's and was gone by 2003. At Scientists Cliffs there was a larger population peaking at 2465 in 1991, then experienced an even greater decline to extinction in 2004. The two populations at Flag Ponds and Western Shores have been the largest and most persistent, but these also declined significantly from the mid-1990s to the present, reaching lowest ever counts in the past two years. There has been no definitive cause identified for this recent major decline, but shoreline changes (the formation of the spit) at Flag eliminated the section of beach where most of the population occurred into the early 1990's. Beetles never really increased in the new spit which formed adjacent to the original shoreline, and numbers remained relatively low since 1997, except for one year (2003) when over 700 were counted. Compared to many *C. dorsalis* population in VA and those in Maryland's Eastern Shore (Janes and Cedar), the size of shoreline habitat occupied by Calvert *C. dorsalis* is small, especially Scientists Cliffs and Cove Point, and even at Flag Ponds after the spit formation. That could be a factor contributing to the decline, especially where the habitat is not of high quality. Beetles have occupied a much great portion of the shoreline at Western Shores, and distribution has changed somewhat over the years. It is possible that when these populations drop to levels of less than 200-500 they are doomed to extinction because of the effects of small population genetic (inbreeding depressing) or ecological (Allee effects) factors. Human impacts may also be involved, not a singular cause, but a contributing factor when populations are stressed or at low numbers. The localized beach where *C. dorsalis* occurred at Scientists Cliffs was quite heavily used, more so during the time of decline. It is difficult to determine if beach walkers have caused impacts at Flag, but that along with the use of a small 4-wheel vehicle ("Mule") to monitor the beaches several times per day may be having effects on larval recruitment and development. There has also been evidence of 4-wheel vehicle use in a section of Western Shores in the past several years. This seems minimal and probably not a major factor. Another potential factor is a change in sand particle size on the beach which seemed to be significantly coarser at least at Flag Ponds, compared to earlier years. Unless there are large numbers of larvae from the 2007-2008 adults at the Flag and Western Shores sites, these populations may be destined for extinction.

Summary Results for *C. dorsalis* at Individual Calvert Sites. Table 5 gives the results of the surveys at all Calvert sites in 2009. Included are the adult numbers for both *C. puritana* and *C. dorsalis*, shoreline characteristics for each section of shoreline, and the coordinates of each waypoint. The locations of these waypoints are shown on the topographic maps included with the report.

Fig. 2. Index counts for the total population of *C. d. dorsalis* in Calvert County, 1986 to 2009.

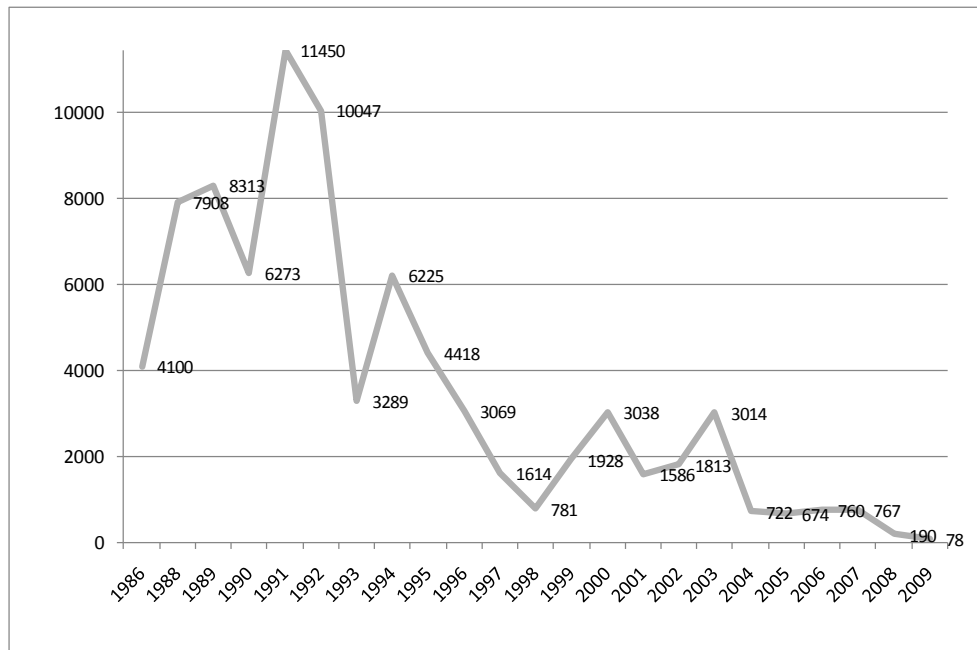


Table 2. Index counts of *C. dorsalis* for all Calvert sites, 1986-2009.

Year	CRsv	Bays	PkM	ScCl	WS+CB	Flag	CCSP	Cove	LCov	CofC	Total
1986	0	0	0	0	3500	500	0	100	0	0	4100
1988	3	0	0	464	4157	2857	0	427	0	0	7908
1989	0	0	0	1634	3392	3084	1	202	0	0	8313
1990		20	0	1874	1479	2188	0	707	0	5	6273
1991	16	37	328	2465	4198	3995	0	406	5	0	11450
1992	0	10	752	1189	3407	4351	1	335	1	1	10047
1993	0	2	49	473	1344	1218	0	196	7	0	3289
1994		9	0	633	3860	1445	0	278	0	0	6225
1995	8	4	0	688	2450	1080	0	188	0	0	4418
1996	1	5	5	673	1380	810	0	192	3	0	3069
1997	0	0	15	510	841	216	0	32	0	0	1614
1998	0	0	0	263	418	68		32	0	0	781
1999	0	0	0	23	1639	210		56	0	0	1928
2000	0	1	7	24	2813	171		22	0	0	3038
2001	0	0	1	0	1353	221		11	0	0	1586
2002	0	4	0	31	1635	130		13	0	0	1813
2003	0	0	1	13	2209	748		42	0	1	3014
2004	0	0	0	0	627	80	4	11	0	0	722
2005	0	0	0	0	623	121	0	0	0	0	744
2006	0	0	0	0	699	61	0	0	0	0	760
2007	0	0	0	0	716	51	0	0	0	0	767
2008	0	0	0	0	188	2	0	0	0	0	190
2009	0	0	0	0	72	6	0	0	0	0	78

Warrior Rest/Scientists Cliffs. Two sections of the shoreline at this site supported populations of *Cicindela d. dorsalis* in the 1990s and until 2003. A large population became established on the beach near the mouth of Parker Creek in 1991 but disappeared by 1994. It is uncertain if these were immigrants from the Scientists Cliffs site to the south, but it seemed apparent that the habitat was not suitable for sustaining a viable population, probably because of its small size and narrow beach that was subject to frequent overwash. A larger and more persistent population became established in the public beach area at Scientists Cliffs in 1988, but after a progressive increase to 2465 in 1991, numbers began a dramatic decline, disappeared by 2001 and none have been found since. Small numbers of adults have been found in some years at the far south end of Scientists Cliffs, but none were found in 2006-2008, and this area is apparently not capable of supporting a viable population.

Western Shores/Calvert Beach. The number of *C. dorsalis* at this site had been relatively small but unusually consistent from 2004 to 2007 (716 in 2007, 699 in 2006, 623 in 2005 and 627 in 2004). However, the numbers dropped precipitously to only 188 in 2008 and now to 72 in 2009. Adults have been variable in distribution over the years, sometimes along all sections but most often in the middle section. In a few years adults have also been present in the northern public beach. In 2004-2005, most adults were in the middle section (near where most *C. puritana* were found) and a smaller concentration in the northern section. However, in 2006 nearly all of the *C. dorsalis* were concentrated in the northern portion of the site and very few in the *C. puritana* section. The distribution changed again in 2007 and 2008 with a southward shift so that adults co-occurred with *C. puritana* over an even broader zone. The cause of the decline in the past two years is uncertain, but could be a result of increasing interaction or competition among the two species. Distribution was similar in 2009 but numbers significantly lower throughout the large middle section of the site. Perhaps more relevant is that the beach at this site has been “progressively moving southward”, with an increasing beach width in the Calvert Beach section. This change has resulted in an extension of the *C. dorsalis* habitat southward into Calvert Beach where *C. puritana* has been dominant. Before 1999 there were few or no *C. dorsalis* within the limits of Calvert Beach part, but the numbers in this section there have increased from 2000 to the present, as the beach has widened. It is uncertain why the beach in the northern half of the site has not supported the numbers of *C. dorsalis* seen in earlier years.

Flag Ponds. The number of adult *C. dorsalis* at this site declined dramatically in the past two years, to only 2 adults in 2008 and 6 in 2009. Numbers at this site have been low over the past 6 years with counts of 51 in 2007, 61 in 2006, 121 in 2005 and 80 in 2004. This decline at this site has been significant since the mid-1990s when there were consistently over 1000 adults. Numbers were even higher into the early 1990s when they reached peaks of over 3000 in several years. The only high count (over 225) in the past nine years was 748 in 2003. That count suggested the population was building back up as adults were recruiting significantly in the northern part of the shoreline at the site. The declines in 2004 and 2005 could have been due to impacts from Hurricane Isabel eroding out many developing larvae in September 2003, thus reducing numbers of adults emerging in 2004 and 2005. However, recovery from this event should have occurred

within a few years as was seen in many Virginia sites. As noted above regular use of a small 4-wheeled vehicle for patrols by park personnel along the shoreline and increased human foot traffic in the past 5-8 years may be a causative factor in the decline.

Cove Point. The population at this site experienced gradual but progressive decline during the 1990's until 2004 when only 11 individuals were counted, and none since then. As with the above Calvert sites, there is no obvious explanation for the extinction except that the section where most beetles occurred in later years was a section that has experienced significant erosion, including a major erosion event in 2008.

Summary of *C. puritana* Trends at Sassafras River Sites, 1989 to 2009. The results of annual surveys at all sites had a total count of 837 in 2009 compared to 1764 in 2008. This count indicates a significant decline after a progressive and significant increase from 2005 to 2008 (408 in 2005, 1221 in 2006, 1566 in 2007, 1770 in 2008). Prior to these years, the total counts declined significantly from 1996 (count of 1821) to 2002 (400) (Fig. 3, Table 3). The lowest ever total numbers were recorded from 1999 to 2004. The counts in 2009 show a consistent and similar proportional decline at all sites (except for a slight increase at East Lloyd) from 2008, with most of the decrease attributed to the decline at Grove Point, the largest population site. This 6-year pattern is similar to that in the Calvert metapopulation with a significant increase over the recent years, then a significant decline in 2009. Some, perhaps most of the low counts in 2009 were a result of unusually high tides during some of the surveys. Although counts were done several hours after high tide, water levels were higher than I recall at any previous surveys. For example, at Grove Point there was cliff breakdown in several sections as the survey was being made. At other sites adults were present on the lower cliff base and more difficult to see since most of the beach was water-covered.

The causes of this similar pattern of abundance in the Sassafras and Calvert metapopulations are unknown as are those factors that caused the significant decline from 1996 to 2005. We have hypothesized that a progressive increase in bluff vegetation occurred during this period and reduced habitat quality, especially for recruitment and larval development. The cliff vegetation and especially that along the back beach and base of the cliffs could have reduced the amount of adult foraging habitat and restricted their movement to suitable oviposition sites on the cliff faces. It may also be that the composition of the vegetation on the cliffs is changing to more invasive species that are more resistant to erosion and/ or more effective in stabilizing the cliff faces. Shoreline and bluff erosion from Hurricane Isabel in 2003 could have countered this trend and reduced cliff face and base vegetation. Consequently, larval habitat improved, recruitment increased and populations of adults began to increase after this time. Because of the two year life cycle of *C. puritana* the improved conditions would take several years to be realized. Other lesser known storms and shoreline events also continue to cause localized erosion, cliff breakdown, etc. and these can complicate the understanding of population fluctuations.

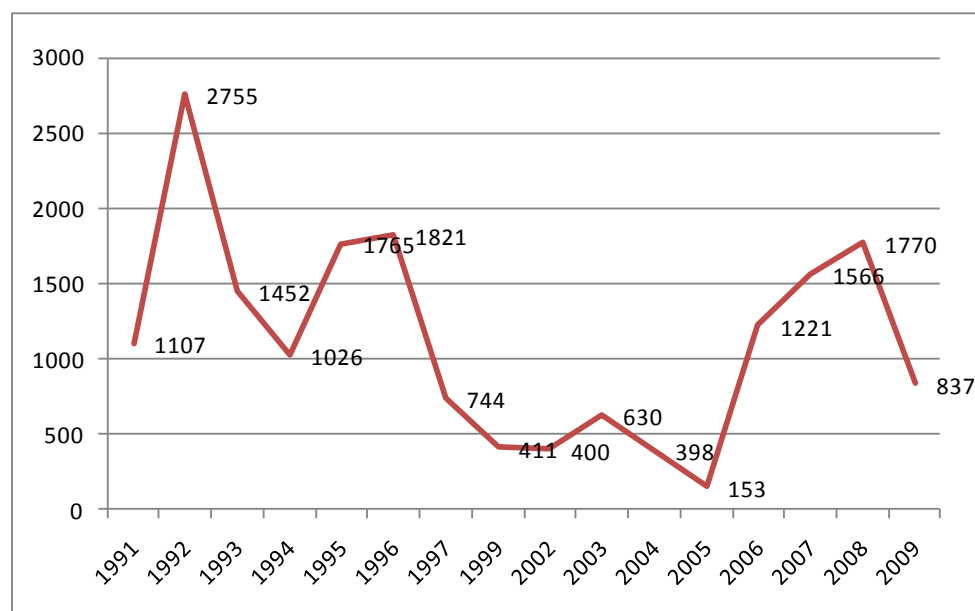
The above hypothesis is uncertain and the effects of vegetation changes may be better understood after another year or two of results from the vegetation removal study

being done at West Turner and East Lloyd. It is also possible that other factors may be involved or more important. Density dependent factors and inherent population dynamics, parasitism or competition from co-occurring species (*C. repanda*) could also be driving some of the changes. Habitat studies at Sassafras in 2008 indicated larvae of both *C. repanda* and *C. puritana* were present in the same bluff microhabitats. Larvae of *C. repanda* were at high densities in low cliff faces during early to mid-summer where adults of *C. puritana* were ovipositing and their larvae developing in late summer into fall. This co-occurrence could have a strong competitive impact on adult *C. puritana* oviposition and early instar larvae.

Table 3. Total index counts of *C. puritana* at all Sassafras sites, 1989-2009.

Sites	1989	1991	1992	1993	1994	1995	1996	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009
Grove Point		1000+	1667	750	567	920	1230	452	150	78	195	254	90(156)	273	843	986	347
Ordinary Point	650	12	215	88	110	208	78	45	120	0	9	40	28	30	53	100	41
North Stillpond.			217	190	87	133	138	92	44	220	119	42	26	143	66	120	99
W. Betterton		79	281	234	160	210	131	78	64	69	126	34	52	23	6	92	55
E. Betterton		0	20	19	40	44	21	28	7	11	16	6	12	6	12	34	15
East Lloyd		9	205	139	15	94	118	30	16	8	160	11	96(73)	554	368	139	115
West Turner	150	0	51	12	47	88	80	19	10	12	3	3	18(4)	172	218	296	165
East Turner	150	7	99	20	0	68	25	0	ns	2	2	8	35	20	0	3	0
Totals	950	1107+	2755	1452	1026	1765	1821	744	411	400	630	398	153	1221	1566	1770	837

Fig. 3. Total index counts of *C. puritana* at all Sassafras sites combined, 1989 to 2009.



Summary Results for Individual Sassafras Sites. Adult counts within the same standard waypoint sections for each of the Sassafras sites 2004-2009 are given in Table 6 (Appendix) along with shoreline characteristics for each section of shoreline. The adult population at Grove Point declined significantly in 2009 after progressive increases in the previous 3 years (1770 in 2008, 1556 in 2007, 1221 in 2006). This site has consistently (except for 2002 and 2006) had the highest counts of all Sassafras sites, usually with half or more of the metapopulation total. Numbers declined after 1996-1997 to a low of 78 in 2002 and remained at less than 300 adults until 2006. As in most recent years the main concentration of adults was from waypoints 61 to 64 where the best combination of beach and especially excellent cliff habitat was present. This section of shoreline was also the most densely populated in 2007 and 2008 which has accounted for most of the increase at this site. Few or no adults were found at the east and west ends of the site. The decline in 2009 is representative of declines at most other Sassafras and Calvert sites, but is also explained at least in part by the very high tide levels during the surveys and coincidental narrow beach area where adults are typically concentrated. This was an especially significant factor at this site and accompanied by several cliff breakdowns observed during the surveys.

Numbers at Ordinary Point declined to 41 from 100 adults in 2008, but are similar to many other recent years. Most adults were concentrated near the north end of the site as in other recent years. Counts at this site were much higher in the mid-1990's, peaking at 215 in 1992. This site includes a long section of shoreline but only limited sections of suitable cliff habitat because much has significant vegetation growth on the cliffs. Another factor is the very little wide beach which reduces overall habitat suitability. This site might be suitable for vegetation removal or management since the substrate seems otherwise suitable were it not for vegetation cover.

North Still Pond had a count of 99 in 2009 compared to 120 in 2008. Numbers at this site have been more stable than most sites, with counts ranging from over 60 to 150 in most years. This may relate to little apparent change in the cliffs or shoreline at this site, except for a slight increase in vegetation in some sections. Adults were present along most of the length of the site and no apparent changes in shoreline or cliffs were noted. One negative feature seems to be the orientation of the beach and cliffs which are shaded much of the day. Some sections of the cliffs have been quite heavily vegetated or rocky and seemingly unsuitable as larval habitat.

The numbers at East Betterton and West Betterton increased significantly at both sites in 2008 (34 and 92, respectively) and the highest sites since 2003. In 2009, numbers declined to levels similar to the mean numbers in the past 10 years, 15 at East Betterton and 55 at West Betterton. The consistently low numbers at East Betterton can be explained by cliffs that are heavily vegetated along most of the length of the site and thus with little breeding habitat. The highest count ever at this site was 44 in 2003. West Betterton has had much higher counts peaking at near or over 200 in the 1990's. Vegetation on the cliffs may have reduced habitat suitability in most recent years. It is similar to East Betterton in shoreline and cliff characteristics, but includes a much longer

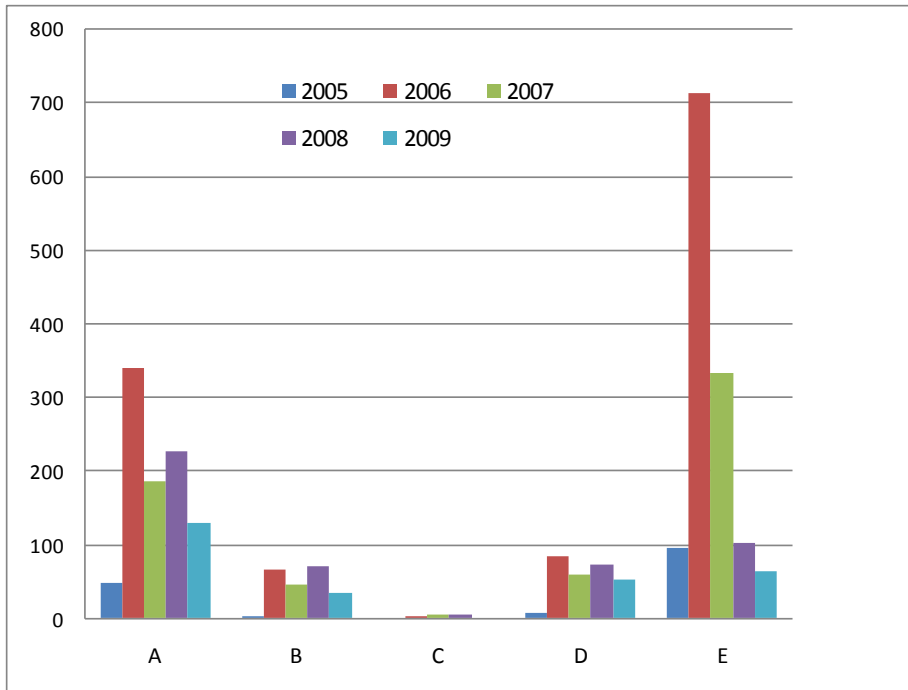
length of shoreline, heavily vegetated or with gravelly or clay soils. Adults have always been concentrated in the eastern end of the site where some sections of bare cliffs exist and absent from the long western section which is fully vegetated and includes some areas with low or no cliffs.

East Turner Creek had no adults in 2009, 3 in 2008 and none in 2007. This site has supported few or no adults in the past 12 years, except for high counts of 35 in 2005 and 20 in 2006 during this period. The site has experienced increased vegetation growth on the cliffs and has a narrow beach, possibly a result of the pier and breakwater constructed at the west end of the site in the early 1990's.

Two adjacent sites on the south shoreline of the Sassafras that have experienced significant population changes in the past five years are East Lloyd and West Turner Creek. These sites are part of experimental study of the effect of vegetation removal on the *C. puritana* population, with each site having a cliff section where vegetation was removed and a paired control section of cliff. Details of this study will be included in another report by McCann, but results of the cliff section surveys are included here. East Lloyd experienced a dramatic increase to 554 adults in 2006, from 96 in 2005, but declined to 368 in 2007, 136 in 2008, and 115 in 2009. This was a control site for the vegetation removal study and the cause of this progressive decline, like the significant increase from 2005 to 2006 is unknown. Observation suggest this decline may be a result of significant cliff breakdown and erosion which seem more prevalent at this site than others in the area. This site, unlike many of the Sassafras sites, is largely unvegetated with considerable amounts of suitable habitat. However, frequent cliff breakdown may result in loss of larvae and pupa in some years, followed by significant recruitment and population increase. Density dependent population factors of *C. puritana* may also be involved. Of interest it that cliff section D of East Lloyd, a vegetation removal site, has had consistently higher counts in the past 4 years following vegetation removal, while the control site, cliff E has experienced a progressive and significant decline (Fig. 4).

Numbers at West Turner, which also included a vegetation removal section (cliff A) and a control site (cliff B), declined to 165 in 2009 after very large increases in the past five years (3 in 2004, 18 in 2005, 172 in 2006, 218 in 2007, 296 in 2008). Increases in 2006 were not a result of the vegetation removal experiment because that was not implemented until late summer 2006. Population changes since then (2007 to 2009) continued significantly higher and could have resulted from improved habitat quality from vegetation removal. Interpretation of results of the vegetation removal study are complicated by the many factors, many unknown, that could affect population dynamics of this species. For example all Sassafras populations declined throughout the mid 1990s and reached lows in 2005, then experienced significant and progressive increase, peaking at most sites in 2008. Although counts (population sizes) at the experimental and control sites are different, the pattern of increase and decrease of the past 5 years seems to be generally similar, except for cliff E where both the increase and subsequent decline in numbers was much greater than other sites.

Fig. 4. Maximum counts of *C. puritana* adults at the vegetation control study along the south shore of the Sassafras River (East Lloyd and West Turner sites), 2005 to 2009.



Surveys for *Cicindela dorsalis dorsalis* on Janes and Cedar Islands. These two sites on Maryland's Eastern Shore have had the two largest populations of *C. d. dorsalis* in Maryland in recent years. They are at the northern end of the species range within the Chesapeake Bay, both isolated, large sites that are not affected by human impacts. The 2009 surveys were conducted by Jim McCann and Andy Moser at Cedar Island and by Barry and Ryan Knisley at Janes Island on July 8. Conditions were sunny and warm and suitable for producing a high level of *C. dorsalis* activity and thus abundance. The methods used were as described above.

The results at specific waypoint sections at these sites are given in Table 6 along with results from several other recent years. It also includes relevant shoreline characteristics and waypoints which are also shown on topographic maps included in the Appendix of this report. **The total number of adult *C. d. dorsalis* counted at Janes Island in 2008 was 1330, compared with 3081 in 2006.** The highest count was 6094 in 2002 and the lowest was 369 in 2004. The distribution in all years have been generally similar with adults present along much of the shoreline, but most adults were in the middle section of the island, waypoints 19-32 and another concentration in the northern end of the site, waypoints 1-12.

The **2009 adult count at Cedar Island was 974, the lowest count at this site since 667 in 1997. Other recent counts were much higher, 2454 in 2006 and 1298 in 2005.** This site has exhibited generally less variation than Janes. The distribution pattern has been similar in most years, with a high concentration of adults in 2006 was similar to previous years, except for a significantly higher number of beetles near the south end of the island. Counts of other co-occurring species were 528 for *C. hirticollis* (compared to 483 in 2004) and 2229 for *C. marginata* (compared to 963 in 2004).

Table 4. Adult counts at Janes and Cedar Islands, 1997-2009.

	<u>1997</u>	<u>1998</u>	<u>2002</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2009</u>
Janes Island	938	1991	6094	369	2475	3081	1330
Cedar Island	669	1495	2464	1095	1298	2454	974

APPENDIX

Table 5. Adult counts of *C. dorsalis* and *C. puritana* along shoreline sections at all Calvert County sites, 2004-2009. See maps for location of waypoints.

Map	CICINDELA DORSALIS COUNTS						CICINDELA PURITANA COUNTS								
Points	2009	2008	2007	2006	2005	2004	2009	2008	2007	2006	2005	2004	Shoreline Notes	LAT	LON
Randle Cliff															
1	0	0	0	0	0	0	0	7		0	0	0	public beach area, then cliffs begin; water level very high in 2005	4282206.00	366690.00
2	0	0	0	0	0	0	0	0		0	0	0	start main area of tall cliffs, very narrow, no beach	4282170.00	366700.00
3	0	0	0	0	0	0	0	0		0	0	0	same	4282169.00	366702.00
4	0	0	0	0	0	0	0	3	2	2	4	8	New breakdown area in 2005	4282063.00	366728.00
5	0	0	0	0	0	0	0	2	3	5	3	3	same, small sections of sandy beach	4281983.00	366763.00
6	0	0	0	0	0	0	0	0		0	18	0	same	4281923.00	366766.00
7	0	0	0	0	0	0	4	4	3	4	0	0	1-2 m wide, poor beach habitat; cliffs ok	4281870.00	366783.00
8	0	0	0	0	0	0	0	1	3	2	0	5	start breakdown with wider beach	4281857.00	366740.00
9	0	0	0	0	0	0	3	0	1	0	0	0	same but no beach; new sandy breakdown, mid height cliffs, dry	4281746.00	366806.00
10	0	0	0	0	0	0	0	1		1	2	8	wide, 3-4 m beach patch, then narrow; dry cliffs, small patch of beach	4281654.00	366832.00
11	0	0	0	0	0	0	0	1	4	1	2	3	narrow, no beach, even at mid-tide	4281501.00	366838.00
12	0	0	0	0	0	0	0	4	5	3	2	0	beach ends, no beach accessible to south, all v. narrow; breakdown at end	4281333.00	366857.00
	0	0	0	0	0	0	7	23	21	18	31	27			
Camp Roosevelt															
13	0	0	0	0	0	0	0	0	0	0	0	0	Start at north end at stream entry, no cliffs then wood area, then tall dry cliffs		
14	0	0	0	0	0	0	0	0	0	0	0	0	South end of site		
					0	0	0	0	0	0	0	0			
Bayside Forest															
15				0	0	0				0	0	0	N of BF, at Plum Point, at yellow house with lawn ornaments	4274428.23	368278.79
16				0	0	0				0	0	0	start series of white houses and no cliffs, some houses damaged by Isabel ?	4274050.32	368201.05
17				0	0	0				0	0	0	few small groins, cliffs fully vegetated, low, then wooded cliffs, trailor park	4273717.98	368134.07
18				0	0	0				0	0	0	creek, rock rip-rap, road bed to beach,	4273392.07	368107.36
19				0	0	0				0	0	0	start high cliffs, no suitable strata	4273246.13	368085.87
20				0	0	0				0	0	0	dry cliffs, most with vegetation	4272931.63	368026.85
21	0	0	0	0	0	0	0	0	0	0	0	0	cliffs end, marsh, creek entry, then woods, then low cliffs	4272475.73	367933.77
22	0	0	0	0	0	0	0	0	0	0	0	0	poor low, vegetated cliffs, breakdown; main survey area here to south+D61	4272131.05	367894.37
23	0	0	0	0	0	0	0	0	0	0	0	0	very tall cliffs, thin section of soft strata	4271673.71	367901.97
24	0	0	0	0	0	0	0	0	0	0	0	0	tall cliff section, narrow beach, many <i>C. repanda</i>	4271513.65	367901.33
25	0	0	0	0	0	0	0	0	see	0	0	0	pier posts in water, then no cliffs, then hard, marl cliffs	4271207.36	367883.21
26	0	0	0	0	0	0	0	0	to	0	0	0	cliffs dry, many fallen trees, then veg. cliffs	4270886.91	367855.87
27	0	0	0	0	0	0	0	0	right	0	0	0	same	4270884.91	367855.84
28	0	0	0	0	0	0	0	0	0	0	0	0	no cliffs, woods, then low cliffs; many <i>C. hirticollis</i>	4270696.80	367846.63
29	0	0	0	0	0	0	0	0	0	0	0	0	low cliffs, field behind, most cliffs bare, 20-25' high	4270437.65	367844.09
30	0	0	0	0	0	0	0	0	3	3*	0	0	start cliffs, lots of trees down, equipment and tracks; many <i>C. hirticollis</i>	4270322.93	367847.95
31	0	0	0	0	0	0	1	5	9	3*	2	0	road access, no cliff section	4270138.63	367883.34
32	0	0	0	0	0	0	0	0	1	0	0	0	low bare cliffs, very wide beach (due to 2004 erosion)	4269824.88	367927.75
													2009: wide beach, 10m, coarse sand and pebbles in ITZ over most of S cliff section of site		
33	0	0	0	0	0	0		0	1	0	0	0	Bayside Forest: south end access, low cliffs, evidence of severe erosion, cutback	4269741.77	367925.50
	0	0	0	0	0	0	1	5	14	6	2	0	*Note that these numbers were incorrectly placed further north in previous reports		
Warrior Rest															
N of 33a	0	0	0			0	0	0	0	3	0		Cliff section north of Parker Creek mouth	4266573	367708
33a	0	0	0	0	0	0	0	0	0	3	12		Far N end, start at beginning of cliffs, S edge of beach (no waypoint)	4266344	367687
33b	0	0	0	0	0	0	11	17	55	182	0			4266059	367729
34	0	0	0	0	0	0	18	96	48	34	13		Near N. end, no access for last 300 meters of cliffs habitat, severe erosion	4266119.45	367764.62
35	0	0	0	0	0	0	25	133	111	275	44		Good cliffs	4265995.33	367799.37
36	0	0	0	0	0	0	133	341	160	394	47		same; creek entry	4265795.36	367829.99
37	0	0	0	0	0	0	74	131	88	222	7		good cliffs, narrow beach; 2 new small breakdown in 2009	4265649.67	367873.71
38=39	0	0	0	0	0	0	205	240	171	275	31		continue tall cliffs; some vegetated cliff sections; 2 new small breakdown in 2009	4265544.85	367896.40
	0	0	0	0	0	0	466	958	633	1388	154		2009: many adults on low cliff face due to very high tides at low tide		
Scientists Cliffs															
40	0	0	0	0	0	0	5	22	25	0	6	26	at creek entry and cove; last groin, tall cliffs begin	4265331.95	367963.69
41	0	0	0	0	0	0	0	0	5	0	2	3	narrow, no cliff habitat	4265159.36	367995.99
42	0	0	0	0	0	0	0	0	4	0	2	0	same, no cliff habitat, beach narrows	4264839.36	368062.58
43	0	0	0	0	0	0	0	9	56	60	2	2	wider beach 6-8 m; old or broken groins, end at creek entry, driveway to beach	4264568.17	368130.93
44	0	0	0	0	0	0	9	25	18	8	4	16	section of rip rap; same, low, veg. cliffs	4264327.43	368210.95
45	0	0	0	0	0	0	11	55	4	12	11	20	same; new gabion in 2005	4264219.09	368244.75
46	0	0	0	0	0	0	6	13	8	1	0	6	continue groins, low or veg. cliffs	4263920.84	368332.12
47	0	0	0	0	0	0		11	10	9	0	0	same, groins	4263758.76	368380.74
48	0	0	0	0	0	0	0	0	0	1	8	20	6 groins, gabion, creek entry, low vegetated cliffs, ORV tracks	4263486.71	368474.83
49	0	0	0	0	0	0	0	0	0	0	0	0	groins end, beach narrows; ORV tracks seen on beach in recent years	4263264.68	368571.49
50	0	0	0	0	0	0	0	0	0	0	0	0	SC North, S end, public beach rock groin, 10-12 m wide beach; heavy beach use	4263137.40	368636.59

51	0	0	0	0	0	0	0	0	0	0	0	2	0	Start Scientist Cliffs South, beginning of north end, groins	4263127.00	368621.00
52	0	0	0	0	0	0	0	1	2	4	0	5		open face cliffs, groins; 3rd, 4th gabions	4262981.00	368641.00
53	0	0	0	0	0	0	0	2	0	2	2	3		semi-vegetative cliffs, groins; most veg. cliffs	4262915.00	368665.00
54	0	0	0	0	0	0	0	3	3	19	9	8		semi-vegetative cliffs, end of groins; wide with breakdown bank	4262820.00	368708.00
55	0	0	0	0	0	0	0	7	16	18	16	12		open face cliffs(last groin at 8715)	4262758.00	368723.00
56	0	0	0	0	2	0	1	3	8	56	29	50		open face cliffs near waterline,	4262698.00	368749.00
57	0	0	0	0	0	0	7	34	34	18	12	12		same	4262638.00	368776.00
58	0	0	0	0	0	0	6	33	13	5	6	71		same, cliffs ending	4262564.00	368815.00
59	0	0	0	0	0	0	0	0	0	0	0	26		rock groin and residence, no open cliffs,far south end	4262435.00	368892.00
	0	0	0	0	2	0	45	218	206	213	111	280				
2009 Notes: nearly all groins are near fully submerged even now at low tide; breakdowns: 449(small); 448(med); 447(sm); 446 (lg); water levels very high																
Western Shores/Calvert Beach																
60	0	0	0	0	1	0	0	0	0	0	0	0		north end of public beach	4261318.48	369396.39
61	0	0	0	1	0	0	0	0	0	0	0	0		narrow beach, ends at creek entry	4261219.24	369451.65
62	0	0	2	76	3	12	0	0	0	0	0	0		very narrow beach	4261067.20	369531.54
63	8	0	6	18	18	30	0	0	0	0	0	0		wider beach	4260966.85	369586.44
64	5	8	27	69	13	60	0	0	0	0	0	0		same, then beach narrows	4260854.48	369643.59
65	3	21	68	63	25	105	0	0	0	0	0	0		same; beach quite shelly throughout	4260744.83	369690.67
66	9	48	27	103	20	43	0	0	0	0	0	0		same, but wider beach	4260660.75	369735.11
67	2	12	8	126	3	24	0	0	0	0	0	0		10-20 m wide beach, Phrag. On back, no cliffs	4260545.77	369802.17
68	4	7	26	103	52	13	0	0	0	10	0	0		vehicle tracks on beach, dense Phragmites on back, and at 2 creeks(2nd creek)	4260411.18	369867.78
69=70	3	0	74	8	4	25	0	3	0	2	10	0		cliffs low, recessed, Phragmites on beach, wide beach, end at first creek	4260233.24	369964.10
71=72	0	5	10	14	8	5	0	20	0	39	12	2		cliffs fully vegetated, trees on back beach	4260112.20	370042.84
73	2	3	40	8	0	7	18	44	25	28	31	30		same but cliffs become heavily vegetated and lower	4259999.63	370105.24
74	0	0	5	0	0	0	17	120	26	18	22	135		beach narrows then widens, tree rubble, cliffs tall, most bare	4259891.53	370186.91
75	0	0	10	0	8	3	6	61	41	66	42	65		vegetated cliffs, become lower, v. wide beach (10-15 m), then narrows	4259813.51	370255.01
76	2	0	3	3	150	16	5	84	25	63	23	115		very tall, excellent cliffs, thick habitat band of soft sand; heavy shrubs at base	4259710.25	370353.16
														Phrag encroaching onto beach		
77	6	18	138	14	240	70	42	150	47	88	35	95		wide beach,heavy Phragmites cover (60+%), heavy shrub cover at base of cliffs	4259618.35	370421.75
														Subtotals for Western Shores		
78	7	6	44	33	74	205	26	143	35	101	28	122		N end Calvert; lower cliffs, good beach, 10-12 m wide, end at creek entry	4259516.99	370518.71
79	3	29	98	32	3	8	11	100	5	150	17	315		continue good cliff habitat, then lower but good, end at large fallen tree	4259432.09	370593.61
80	9	2	23	25	1	0	4	100	16	247	11	260		excellent high cliffs with wide habitat band, 3-5 m wide beach	4259378.77	370644.76
81	2	2	36	3	0	0	10	16	32	68	1	96		start bare cliffs, soft ideal upper strata	4259341.01	370680.54
82	3	7	17	0	0	0	4	16	6	0	25	0		upper cliffs vegetated and recessed, lower part is marl, 2-4 m wide beach	4259297.40	370721.02
83	0	11	29	0	0	0	0	3	0	0	19	0		North most groin, then bare cliffs, narrow beach	4259252.57	370782.25
84	2	9	25	0	0	0	0	2	0	0	0	0		groin, cliffs fully vine covered, 5-7 m wide beach, new sand bags?	4259032.11	370983.60
85	2	0	0	0	0	0	0	0	0	0	0	0		Calvert Beach and WSE: Start at access, creek, start cliffs	4258960.66	371022.77
86	0	0	0	0	0	0	0	0	0	0	0	0		Calvert Beach South, cliffs, residential, groins(09: all hirts in groin part)	4258899.00	371078.00
87	0	0	0	0	0	0	0	0	0	0	0	0		cliffs, end of groins	4258760.00	371228.00
88	0	0	0	0	0	0	0	0	0	0	0	0		residential, end of cliffs, starts flat back-beach	4258650.00	371340.00
89	0	0	0	0	0	0	0	0	0	0	0	0		far south end, residential, at jetty,	4258458.00	371687.00
		0	0		78	214					57	837		Subtotals for Calvert Beach		
	72	188	716	699	623	627	143	841	273	886	232	1279				
Flag Ponds																
90	4	2	1	2	6	8	0	0	0	0	0	0		North end, natural area,, avg 15ft back-beach to lagoon, beach narrow to gone	4257143.00	372756.00
91	2	0	3	1	1	0	0	0	0	0	0	0		natural area,, practically no back-beach	4256999.00	372920.00
92		0	2	2	30	17	0	0	0	0	0	0		natural area,, avg 5-10ft back-beach	4256918.00	373018.00
93		0	10	26	40	23	0	0	0	0	0	0		natural area,, avg 15-20ft back-beach	4256860.00	373094.00
94		0	13	23	18	15	0	0	0	0	0	0		natural area, avg 40-50ft back-beach	4256775.00	373164.00
95		0	9	0	0	0	0	0	0	0	0	0		start natural area; new accretion point	4256690.00	373168.00
96		0	5	6	3	3	0	0	0	0	0	0		no cliffs, avg 10-15ft back-beach to grass dunes	4256595.00	373050.00
97		0	8	1	23	14	0	0	0	0	0	0		no cliffs, avg 10-15ft back-beach to grass dunes	4256419.00	373057.00
98		0		0	0	0	0	0	0	0	0	0		pier	4256265.00	373114.00
99		0		0	0	0	0	0	0	0	0	0		south of pier to boundary fence	4256260.00	373137.00
	6	2	51	61	121	80	0	0	0	0	0	0				
Calvert Cliffs Nuclear Power Plant																
100		0	0	0	0	4	0	0		0	no	0		North beach, wide beach, avg 20ft back-beach, no cliffs	4256074.00	373233.00
101		0	0	0	0	0	0	0		0	surv	0		same	4255928.00	373341.00
102		0	0	0	0	0	0	0		6	0	0		cliffs, avg 5ft back-beach	4255840.00	373426.00
103		0	0	0	0	0	0	0		0	0	0		cliffs, no back-beach	4255707.00	373559.00
104		0	0	0	0	0	0	0		3	0	0		same	4255538.00	373748.00
105		0	0	0	0	0	0	0		0	2	0		Start south of pier, main survey area, very rocky beach, no width, good cliffs	4254774.00	374636.00

106	0	0	0	0	0	2	0	6	6	0	same	4254697.00	374681.00
107	0	0	0	0	0	2	0	0	0	0	same	4254633.00	374786.00
108	0	0	0	0	0	8	2	7	6	6	same but wider beach	4254597.00	374818.00
109	0	0	0	0	0	33	10	43	13	44	wider sandy with shells beach (1-2 m)	4254527.00	374884.00
110	0	0	0	0	0	11	8	11	10	3	breakdown, rocky point, little habitat	4254412.00	374979.00
111	0	0	0	0	0	48	6	4	0	0	same, all very rock and no beach habitat	4254325.00	375085.00
112	0	0	0	0	0	2	4	0	0	0	same	4254288.00	375119.00
113	0	0	0	0	0	6	5	12	0	6	same but with sandy patches of beach; narrow some rocky, some sand	4254240.00	375146.00
114	0	0	0	0	0	8	11	36	6	18	arc beach, most sandy, 1-2 m	4254151.00	375163.00
115	0	0	0	0	0	6	24	23	36	28	same; rock, gravel, sand, medium width big breakdown just to south	4254053.00	375215.00
116	0	0	0	0	0	85	21	66	3	8	same	4253912.00	375341.00
117	0	0	0	0	0	12	4	28	0	0	point, rocky, no beach; very marginal, most beetles at S end	4253859.00	375397.00
118	0	0	0	0	0	26	21	45	19	6	start wide sandy beach, low cliffs	4253689.00	375475.00
119	0	0	0	0	0	0	0	0	0	0	end just to south, all hirticollis, no puritana habitat	4253617.00	375545.00
Calvert Cliffs State Park													
201	0	0	0	0	0	60	228	3	20	0	Farthest N that can be accessed, rocky shoreline, no beach, even at low tide	4252322	376584
						38					N end of cliffs;		6630
202	0	0	0	0	0	44	68	125	41	30	Here to north, very narrow, little beach habitat, but cliffs good	4251961	376687
											wider beach sections and good cliffs		6794
											start cliffs, no beach, inaccessible		6700
203	0	0	0	0	0	215	318	23	9	0	marsh and beach section, no habitat	4251855	376794
													6858
204	0	0	0	0	0	120	264	87	168	110	tall cliffs, tree rubble, narrow beach, then 4-5 m wide beach with most beetles	4251711	376896
													6906
											beach narrows, little or no width		6968
205	0	0	0	0	0	0	97	0	28	70	trail accessing beach, very narrow beach, dry cliffs, then good top cliff area	4251569	376987
206	0	0	0	0	0	12	46	5	8	0	marsh area and beach, no cliffs, no habitat	4251447	377087
207	0	0	0	0	0	158	475	29	30	11	very narrow beach, excellent cliffs; new breakdown in 2009	4251334	377139
208	0	0	0	0	0	15	67	7	8	10	arc beach, 0-1 m wide beach, then 2-3 m wide	4251150	377244
209	0	0	0	0	0	4	46	13	26	11	mid, tall cliffs, good, 2-4 m wide beach, end at Rocky Point	4250975	377300
210	0	0	0	0	0	0	0	0	0	0	south end of site, cliffs no beach		
	0	0	0	0	0	666	1609	292	338	242			
Cove Point													
120	0	0	0	0	0	0	0	0	0	0	Cove Point: start at north end, N of pier where beach starts; 2-3 m marsh behind	4250383.35	377646.58
121	0	0	0	0	0	0	0	0	0	0	same	4250335.94	377706.05
122	0	0	0	0	0	0	0	0	0	0	pier	4250264.84	377783.59
123	0	0	0	0	0	0	0	0	0	0	narrow arc beach, with water behind	4250207.16	377810.49
124	0	0	0	0	0	0	0	0	0	0	dense Phragmites behind, coarse sand, narrow beach, 0-2 m	4250130.76	377907.96
125	0	0	0	0	0	0	0	0	0	0	GPS tube about 8 m offshore, phragmites on beach	4250072.66	377977.31
126	0	0	0	0	0	0	0	0	0	0	narrow beach	4250005.28	378036.22
127	0	0	0	0	0	3	0	0	0	0	beach wider, 1-2 m then widens to 5-7 m	4249958.70	378129.25
128	0	0	0	0	0	8	0	0	0	0	wide beach, 6-10 m wide; still Phragmites behind	4249915.53	378260.68
129	0	0	0	0	0	0	0	0	0	0	start first trees on back of beach; 8-12 m wide	4249879.53	378359.20
130	0	0	0	0	0	0	0	0	0	0	same, beach wider	4249822.44	378523.70
131	0	0	0	0	0	0	0	0	0	0	very wide beach, 20+ m	4249762.29	378699.79
132	0	0	0	0	0	0	0	0	0	0	same, intertidal sand is soft	4249721.56	378854.50
133	0	0	0	0	0	0	0	0	0	0	same	4249668.66	379073.50
134	0	0	0	0	0	0	0	0	0	0	end at north end of lighthouse	4249605.74	379242.64
	0	0	0	0	0	11	0	0	0	0			
Cove Point Hollow													
135					0					0	no cliffs, residential crescent beach	4248963.00	378822.00
136					0					0	no cliffs, residential crescent beach	4248871.00	378750.00
137					0					0	no cliffs, residential crescent beach	4248652.00	378619.00
138					0					0	no cliffs, residential crescent beach	4248399.00	378519.00
139					0					0	vegetative cliffs, residential,	4248191.00	378473.00
					0					0			
Little Cove Point- July 6													
140	0	0		0	0	0	32	0	0	0	cliffs, avg 20ft back-beach to cliffs, end open cliffs at this point	4247990.00	378548.00
141	0	0		0	0	0	47	14	21	8	cliffs, avg 4ft back-beach, lower 2/3 fully vegetated in 2009	4247932.00	378543.00
142=143	0	0	0	0	0	0	0	0	0	0	Cove Point Lake/Cove Lake, cliffs; beach end of cliffs	4247859.00	378548.00
144	0	0	0	0	0	0	0	0	0	0	start revetment	4247767.00	378578.00
145	0	0	0	0	0	0	60	25	0	0	end revetment	4247655.00	378624.00

146	0	0	0	0	0	0	7	99	29	22	0	11	Bannister point, arc beach; small breakdown	4247591.00	378668.00
147	0	0	0	0	0	0	16	161	13	40	0	3	same	4247522.00	378667.00
148	0	0	0	0	0	0	20	67	61	39	53	7	start point, then arc beach, low but good cliffs, breakdown area	4247387.00	378696.00
149	0	0	0	0	0	0	30	19	85	24	17	30	same, then high cliffs; good cliffs, wide beach; deck and stream entry	4247283.00	378706.00
150	0	0	0	0	0	0	9	17	3	2	4	0	no cliffs, then low cliffs; wood steps, terrace, rock revetment, set back	4247164.00	378755.00
151	0	0	0	0	0	0	22	8	43	11	5	0	point, then narrow arc beach, cliffs get lower	4247096.00	378822.00
152	0	0	0	0	0	0	3	73	52	0	0	0	another point section, then arc beach, no cliffs	4246977.00	378853.00
153	0	0	0	0	0	0	14	59	73	24	23	5	same, point; breakdown; 4th, N most pipe on back; breakdown; N end balls	4246798.00	378792.00
154	0	0	0	0	0	0	0	30	22	24	15	0	start point, no beach, good cliffs, break; drainage pipes on cliff sand bags	4246704.00	378742.00
													2009: south end reefballs, fully submerged at low tide, cliffs behind stabilizing		
155	0	0	0	0	0	0	0	3	15	26	4	16	same, medium cliffs, wide beach; stream channel and steps	4246584.00	378663.00
156	0	0	0	0	0	0	13	0	19	6	0	0	wider beach, low cliffs; hard cliffs	4246494.00	378601.00
157	0	0	0	0	0	0	12	77	27	11	6	2	same; massive breakdown	4246440.00	378572.00
158	0	0	0	0	0	0	7	21	5	90	9	4	same; breakdown, very high cliffs; massive breakdown	4246319.00	378518.00
159	0	0	0	0	0	0	0	46	23	33	22	6	mini-point, then recessed arc beach, narrow beach, good cliffs	4246233.00	378483.00
160	0	0	0	0	0	0	31	34	24	74	39	17	same, very high, good cliffs	4246147.00	378420.00
161	0	0	0	0	0	0	5	85	18	58	18	33	tree rubble but 1 m beach and good cliffs; breakdown	4246082.00	378376.00
162	0	0	0	0	0	0	29	8	29	36	15	22	same; N end of balls	4246018.00	378322.00
163	0	0	0	0	0	0	32	18	0	0	5	10	start good cliffs, 2 m beach, cliff terraced at top	4245951.00	378279.00
164	0	0	0	0	0	0	36	20	35	0	0	0	rock groin and rip rap (40 m long); S end of revetment	4245934.00	378254.00
165	0	0	0	0	0	0	8	6	0	0	4	8	start good cliff habitat; 1 m wide beach	4245870.00	378196.00
166	0	0	0	0	0	0	0	0	0	0	0	0	same	4245813.00	378153.00
167	0	0	0	0	0	0	0	0	0	0	0	0	wide beach, more groins; @ 12 total	4245723.00	378082.00
168	0	0	0	0	0	0	0	0	0	0	0	0	rock groins at south end of beach, then beach	4245646.00	378012.00
													4 rock groins at south end of beach		
169	0	0	0	0	0	0	2	41	0	0	9	0	cliffs low, no habitat	4245561.00	377925.00
170	0	0	0	0	0	0	2	17	26	2	8	6	same, beach slightly wider; North end of revetment; no beetles behind revet	4245497.00	377878.00
171	0	0	0	0	0	0	8	53	14	40	14	13	eroded beach, tree rubble, but good cliffs; N end of balls; very large breakdown	4245446.00	377834.00
172	0	0	0	0	0	0	24	15	85	32	20	36	S. end, start cliffs, 1-2 m beach, good cliff habitat	4245383.00	377774.00
	0	0	0	0	0	0	330	1116	740	615	298	251			
Cliffs of Calvert															
173	0	0	0	0	0	0	0	0	6	0	0	0	N end, rock pile, then small pond, no habitat; 50 m long revetment	4245303.00	377719.00
174	0	0	0	0	0	0	0	0	0	0	0	0	no habitat; breakdown and minipoint	4245157.00	377615.00
175	0	0	0	0	0	0	0	0	0	0	0	0	same; jus N of N end of balls	4245058.00	377552.00
176	0	0	0	0	0	0	0	9	9	0	0	0	start creek and marsh with no beach, no habitat	4244953.00	377484.00
177	0	0	0	0	0	0	3	0	3	21	4	6	start good cliff habitat; several small breakdowns	4244878.00	377427.00
178	0	0	0	0	0	0	5	7	26	15	2	0	same; small breakdown	4244838.00	377392.00
179	0	0	0	0	0	0	28	52	51	0	0	0	lower cliffs, then vegetated cliffs; S end of balls; small rock pile	4244759.00	377325.00
180	0	0	0	0	0	0	5	183	0	16	6	6	same	4244700.00	377281.00
181	0	0	0	0	0	0	26	31	34	8	0	18	wider beach, good cliff habitat	4244638.00	377236.00
182	0	0	0	0	0	0	21	154	20	24	11	3	continue good cliff habitat	4244609.00	377217.00
183	0	0	0	0	0	0	12	59	7	4	1	2	same	4244538.00	377166.00
184	0	0	0	0	0	0	20	175	14	13	1	5	same; new breakdown, north end	4244504.00	377146.00
185	0	0	0	0	0	0	60	144		10	2	2	same; new medium breakdown at north end	4244409.00	377075.00
186	0	0	0	0	0	0	36	13	0	0	0	0	same; 0-1 m wide beach; new breakdown	4244312.00	377018.00
187	0	0	0	0	0	0	3	2	2	0	3	0	good cliffs with no beach	4244241.00	376974.00
188	0	0	0	0	0	0	0	0	0	0	0	0	end rip rap, start good cliff habitat, no beach	4244162.00	376920.00
189	0	0	0	0	0	0	0	0	0	0	0	0	S. end, start N of beach at large house with rip; rock pile, no beach, too narrow	4244057.00	376863.00
	0	0	0	0	0	0	219	829	172	111	30	42			

Table 6. Adult counts of *C. puritana* along shoreline sections at all Sassafra sites, 2004-2009. See maps in Appendix for location of waypoints.

Map Pt.	2009	2008	2007	2006	2005	2004	Latitude	Longitude	Shoreline Characteristics
Grove Point									
057		0	0	0	0	0	4360277.00	410540.00	E end of site; dry cliffs, sand and some pebbles//very dry cliffs, 6-7 m beach, all bare
058	0	3	0	0	0	0	4360333.00	410498.00	very rocky, no beach, -1 m wide, cliffs vegetated//gets rocky, then trees;
059	4	11	7	3	5	4	4360415.00	410410.00	wider beach, good cliffs, 1 m, then tree rubble//wide beach, 6 m, ok cliffs
060	33	93	25	11	2	1	4360515.00	410374.00	narrow, -1 m wide, very good cliffs, then 1 m wide
061	44	169	143	39	7	15	4360577.00	410341.00	good cliffs, 1 m wide beach, earlier this was best prime section; cliff breakdown in 2009
062	41	113	111	92	14	0	4360639.00	410327.00	start pebble and stone beach, very narrow, cliffs veg., no habitat
063	125	353	166	81	61	146	4360695.00	410328.00	start good cliffs, 0-1 m wide, previously good, beach narrow; massive cliff
			78				60761	10334	breakdown in 2009
			139				60808	10339	
064	72	123	59	18	39	29	4360888.00	410361.00	good cliffs, same beach but then narrows// southern half very good sand beach and
065	21	47	49	11	7	18	4360950.00	410368.00	good cliffs but pebble, rocky beach, 1 m wide/still good cliffs
066	0	6	6	0	0	6	4361051.00	410387.00	very rocky, good cliffs end, then vegetated and non-habitat, road enters shoreline
067	0	6	12	0	0	12	4361138.00	410403.00	start N of road, narrow beach, 0-1 m, good upper cliffs
068	8	12	8	12	3	6	4361270.00	410472.00	same, some ok cliffs, 0 m beach
069	0	0	0	3	0	0	4361359.00	410507.00	low cliffs, no beach, -2 m wide
							4361384	410506	south end of new revetment; all logs and sticks behind revetment in 2007
070	0	0		0	18	8	4361401.00	410527.00	start bare cliffs, newly eroded, narrow beach/same
			38				4361427	410545	N end of revetment
071	0	0	0	0	0	0	4361506.00	410594.00	cliffs are ok habitat, beach ok, cliffs end, no habitat
072	0	0	0	0	0	3	4361552.00	410622.00	start low cliffs, ok habitat
073	0	0	2	0	0	0	4361586.00	410642.00	continue low, no cliffs
195	0	0	0	0	0	0	4362115.00	411315.00	Grove Neck, north end; gray clay, 12 m high then lower
196	0	0		0	0	0	4362060.00	411170.00	very rocky with many trees down/metal stakes; photo looking south, pier at top
197	0	0		0	0	1	4361936.00	410939.00	gray clay then red sand and rock; large sand stones on beach
198	0	0		3	0	5	4361720.00	410734.00	gray clay, 12 m high, then red sand top, very rocky beach
199	0	0		0	0		4361586.00	410647.00	end, meet bk
	347	986	843	273	156	254			
North Grove Point									
074	0	n	n	no	0	0	4362490.00	412209.00	rocky with sand, 1.5 m low dry cliffs, tree rubble
075	0	n	n	survey	0	0	4362446.00	412101.00	red sand cliffs at top, bare, ok habitat
076	0	n	n	in	0	0	4362392.00	411990.00	all clay cliffs, no habitat
077	0	n	n	2006	0	0	4362371.00	411945.00	end, meet jim, photo
200	0	n	n		0	45	4362317.00	411799.00	rocky beach, trees down; going N, new site, north of 200
201	0	n	n		0	0	4362368.00	411938.00	end site
					0	45			
Ordinary Point									
083	0	0	0	0	0	3	4359852.00	414418.00	Ordinary Pt. West, N end, dry stoney cliffs, 0-1 m wide
084	11	15	10	2	1	0	4359810.00	414442.00	good cliffs, no beach, then rocky cliffs, fully vegetated, tree rubble
085	21	33	0	5	15	22	4359753.00	414538.00	good cliffs, tree rubble, narrow beach, sandy
086	9	24	40	23	12	12	4359726.00	414570.00	breakdown, then ok cliffs, sandy 1 m wide
087	0	22	0	0	0	0	4359669.00	414655.00	end habitat
088	0	0	3	0	0	0	4359558.00	414922.00	continue Ordinary, N end, veg cliffs narrow to no beach, all tree rubble
089	0	0	0	0	0	3	4359508.00	414970.00	1 m beach and very veg. cliffs
090	0	0	0	0	0	0	4359464.00	415011.00	same
091	0	0	0	0	0	0	4359385.00	415062.00	same, end site
207	0	0	0	0	0	0	4359309.00	415117.00	variable beach width
208	0	0	0	0	0	0	4359384.00	415061.00	end of site
	41	100	53	30	28	40			
East Turner									
024	0	3	0	0	3	0	4357503.00	415759.00	East Turner Ck.; 0 m wide beach, tree rubble, good cliffs
025	0	0	0	0	1	0	4357525.00	415813.00	same
026	0	0	0	0	0	5	4357535.00	415831.00	same, good cliffs
027	0	0	0	17	30	0	4357556.00	415861.00	1 m beach width, cliffs low and very vegetated
028	0	0	0	3	1	3	4357587.00	415906.00	
029	0	0	0	0	0	0	4357627.00	415961.00	end at breakwater, shaded; photos 1, 2
	0	3	0	20	35	8			
West Turner									
082	35	71	45	104	8	0	4357964.00	413531.00	West end of site; gravelly beach, many small trees down
206	90	155	152	68	18	3	4358153.00	413887.00	many downed trees, many larvae in fall down (repanda?); Section A
205	40	67	21	0	0	0	4358284.00	414014.00	east end of site
	165	293	218	172	26	3			

[illegible]

Table 6. Multiple counts for vegetation removal study sites (West Turner and East Lloyd) in 2009.

Date	Cliff section	Replicate	Observer	Start time	End time	Start waypt	End waypt	puritana
7/10/2009	A	1	RDK	1120	1145	A1	A2	1
						A2	A3	0
						A3	A4	12
						A4	A5	13
						A5	A6	18
						A6	A7	11
						A7	A8	7
						A8	A9	0
							Total	62
7/10/2009	A	3	CBK	1430	1445	A1	A2	2
						A2	A3	14
						A3	A4	31
						A4	A5	22
						A5	A6	5
						A6	A7	12
						A7	A8	11
						A8	A9	1
							Total	98
7/10/2009	A	2	CBK	1310	1340	A1	A2	0
						A2	A3	18
						A3	A4	29
						A4	A5	31
						A5	A6	22
						A6	A7	24
						A7	A8	6
						A8	A9	0
							Total	130
7/8/2010	B	1	RDK	1250	1255	B1	B2	0
						B2	B3	0
						B3	B4	0
							Total	0
7/10/2009	B	2	RDK	1345	1355	B4	B3	1
						B3	B2	22
						B2	B1	12
							Total	35
						B1	B2	3
7/10/2009	B	2	CBK	1240	1255	B2	B3	17
						B3	B4	7
							Total	27
7/8/2009	C	1	RDK	1400	1420	C1	C2	0
						C2	C3	0
						C3	C4	0
							Total	0
7/10/2009	C	2	CBK	1210	1220	C1	C2	0
						C2	C3	0
						C3	C4	0
							Total	0
7/10/2008	C	3	CBK	1500	1510	C1	C2	0
						C2	C3	0
						C3	C4	0
							Total	0
7/8/2009	D	1	CBK	1300	1310	D1	D2	0
						D2	D3	0
						D3	D4	6
						D4	D5	7
						D5	D6	0
						D6	D7	0
						D7	D8	4
						D8	D9	2
						D9	D10	0
						D10	D11	0
							Total	19
7/10/2009	D	2	CBK	1520	1530	D1	D2	0
						D2	D3	0
						D3	D4	12
						D4	D5	3
						D5	D6	0
						D6	D7	0
						D7	D8	8
						D8	D9	20
						D9	D10	1
						D10	D11	0
							Total	44
7/10/2008	D	3	RDK	1549	1604	D1	D2	0
						D2	D3	2
						D3	D4	14
						D4	D5	11
						D5	D6	0
						D6	D7	2
						D7	D8	9
						D8	D9	13
						D9	D10	0
						D10	D11	1
							Total	52
7/8/2009	E	1	CBK	1230	1245	E1	E2	17
						E2	E3	11
						E3	E4	5
						E4	E5	0
							Total	33
7/10/2009	E	2	CBK	1100	1120	E1	E2	41
						E2	E3	19
						E3	E4	3
						E4	E5	0
							Total	63
7/10/2009	E	3	RDK	1430	1440	E1	E2	31
						E2	E3	21
						E3	E4	0
						E4	E5	2
							Total	54

Table 7. Numbers of adult *C. d. dorsalis* in specific way point sections at Janes and Cedar Islands in 2009 and other recent years.

Janes Island							
Map	Alternate						
Waypt.	Waypt	2009	2005	2004	2002	Shoreline Characteristics	
1	1	17	18	48		Far NE tip; unveg. 12-40 m wide spit w/some mudflats; little wrack; most Cdd on N side of spit; spit narrows	38.0312170
2	2	17	52	15		10-16 m wide beach w/25-40% covered by thick wrack; 3-5% with <i>Sp. alterniflora</i> .	38.0331500
3	3	20	33	17		8-12 m wide sand beach w/10-15% wrack cover and no <i>S. alterniflora</i> . Coarser sand.	38.0345000
4	4	36	30	19	585	10-20 m wide beach w/20% wrack cover, mouth of Thru Creek.	38.0365170
5,6	5	65	67			mouth of small tidal creek	38.0377500
7	6	83	1		11	same	38.0271670
8	7	8	42		180	narrow beach, marginal habitat, some wrack	38.0269830
9	8	82	112			beach widens, good habitat section	38.0273500
10	9	12	279			same	38.0260500
11	10	82	26			wide beach, 3-5 m	38.0242500
12	11	91	0		258	N of Rock Hole, wide beach, good habitat	38.0225830
13	12	25	60		880	same	38.0216000
14,15	13	40	57	46		NW corner of small bay	38.0203670
16	14	39	4	1		E shore of Rock Hole; all Cdd concent. in 30-40 m section; 12-20 m sandy; little Cdd habitat elsewhere	38.0170500
17	15	20	18	12		E shore Rock Hole; steep narrow beaches with wrack shores/little or no beach; all Cdd conc at creek outlet.	37.9700500
18	16	4	0			Series of short wide, 20-30 m sand beaches w/intervening <i>S. alterniflora</i> line beaches and mud flats.	37.9716670
19	17	0	0	6		Began at small creek outlet; 15-40 m wide by 70-80 m long.	37.9725170
20,21	18	0	0		130	Little sand beach; most shoreline bordered by <i>S. alterniflora</i> , thick wrack w/5-15 m wide beach behind	37.9737
22	19	0	15			Nice long (200-300 m) beach w/well developed foredune but few Cdd; section ends at picnic area	37.975067
23	20	8	456		280	most narrow beach.	37.976567
24	21	49	280			long section of marsh beach, wide 3-5+ m	37.979767
25	22	57	74		304	similar good habitat	37.98385
26	23	47	58			same	37.98575
27	24	168	119			sandy marsh beach, 3-6 m wide; good habitat	37.98885
28	25	0	12		1822	beach narrows	37.991417
29	26	0	81		440	march behind beach	37.9942
30,31	27	87	188			Creek outlet	37.9921
32	28	0	292	72		Stumps in intertidal	37.9914
33	29	53	57	86		Green buoy	37.9888
33	30	0	37	27		end of section;	37.9857
34	31	112			718	good Cdd habitat.	37.9838
35	32	0	7	9		good Cdd habitat. Most w/30-100 m long sections of 8-12 m wide sandy beach w/30% wrack cover.	37.9798
36	33	0	0	2		Half of section w/5-10 m wide beaches; wrack w/narrow, 2-6 m wide coarse beach	37.9766
37	34	72	0		177	small sections of 10-15 m wide sandy beach but most (70-80%) of shoreline bordered by tump and wrack.	37.9751
38	35	17	0			began at small pt ~100 m N shoreline bordered by <i>S. alterniflora</i> w/narrow coarse sandy beach behind it.	37.9737
39	36	3	0	2		N of SW tip, no suitable habitat. Much beach covered by wrack.	37.9725
40	37	4		2		4th rock groin; 40-50% shoreline armored by large rock; 10-18 m wide sand beach w/30-50% wrack cover.	37.9717
41	38	0			309	at 3rd rock groin. 10-15 m wide sand beach w/10-20% wrack cover. No foredune behind beach.	37.97
42	39	0		5		Began at 2nd rock groin. 10-15 m wide sand beach w/30% wrack cover.	37.9723
43	40	12				S end of Island; House Cove and started at large rock groin; 10-15 m wide beach w/30% wrack	37.9697
		1330	2475	369	6094		
Cedar Island		2009	2005	2004	2002		
44,45	1	7		25		spit on south side	37.9537
46	2	16	22		318	wrack on beach, 0-3 m wide	37.951433
47	3	14	103	33	203	same, beach widens, much wrack on beach	37.949917
48	4	79	144	35		start open sand spit, some veg.	37.947233
49	5	43	71	18	368	west end, wide beach and open sand spit	37.94555
50,51	6	26	107	86	533	begin peat area, wide beach, 30% wrack cover	37.942917
52	7	62	5	70		good habitat; long 10-15 m wide sandy beach w/30% wrack cover and well developed foredune.	37.941517
53	8		214	185	208	same, beach widens, much wrack on beach	
54-57	9	454	244	354	746	good habitat; most wide (10-15 m) beach w/20-30% wrack cover w/intervening sections of wrack shorelines.	37.92995
58	10	100	321	273		8-14 m wide sandy beach w/30-50% wrack cover. Beach narrower w/more wrack than previous two sections.	37.9393
59	11	48	39	10	20	Narrow, 5-10 m wide beach w/heavily wrack-lined shoreline. Section ended at <i>S. alterniflora</i> vegetated tip.	37.92995
60	12	125	50	6	68	Marginal Cdd habitat. Heavily wrack-lined, narrow, 5-10 m wide sandy beach.	37.92845
61		974	1298	1095	2464	S end of island, north end of small beach	37.926117
62						detached section	
63						detached section	

TOPO MAPS OF ALL CALVERT AND EASTERN
SHORE SITES SHOWING STANDARDIZED
WAYPOINTS (SEE TABLES 4-6 FOR BEETLE
COUNTS)